ASIC 2016
SOUTHWEST REGIONAL CONFERENCE
April 8th, 2016
Prescott, Arizona
Jeffrey Bruce
The Future of Green

Jeffrey L. Bruce, FASLA, LEED, ASIC, GRP
What is a Green Roof?

A green roof is a green space created by adding layers of growing medium and plants on top of a traditional roofing system.
Hanging Towers of Babylon (450 BC)
Green Roofs are as old as America
1981 Green Roof
“Green roofs and green walls is expected to surge to $7.7 billion by 2017. Installations of green roofs will rise 70% by then, to 79.76 square miles.”

Lux Research, 2012

Source: ASLA
“Unlike other “green” sectors adoption is not driven by national-level policy measures, but entirely by city-level hyperlocal priorities.

- Building code requirements and mandates.
- Financial incentives.
MARKET DRIVERS

Value Proposition against Competing Technologies is a Major Barrier for Adoption.
Value Proposition against Competing Technologies is a Major Barrier for Adoption.

Source: Tremco
Significant challenges remain in performance measurements and estimating payback periods, and clients should expect to see the following trends emerge.

• Financial concerns will dictate choice of vegetation.

• Building materials companies will develop special waterproof membranes and geosynthetic fabrics.

• Payback periods become an important metric.

• Technologies increasingly integrate with other innovative building materials.
THE RISE OF LIVING ARCHITECTURE

ASIC Southwest Regional Conference
“There is no shortage of water in the desert unless you try to establish a city where no city should be.”

“An animal exhibit is an intensive care hospital with a pretty frame for interpretation.”

John Coe
ALTERATION of NATURE
ASIC Southwest Regional Conference
Water as Fuel

We can’t build greener cities simply by wasting less energy and water. The idea of net zero water is that we can actually **harness the power of nature** to restore our rainwater, air, and ground water.
Aesthetic vs. Function

Horticulture

Ecology
Consumptive vs. Restorative Horticulture Ecology

ASIC Southwest Regional Conference
Landscapes as Living Machines

OPEN AEROBIC REACTOR I
Aerated open tanks contain plants that are adapted to a high strength wastewater environment. During the process, the organic contaminants are converted into bacterial biomass.

CLARIFIER
Bacterial biomass is separated from water and recycled to the front to continue to digest the soluble organic content of the wastewater. A small fraction is removed as excess sludge.

ANAEROBIC REACTOR
For the pretreatment of high strength wastewater or for biological phosphorus removal in tertiary treatment.

VENTILATION

INFLUENT

CONSTRUCTED WETLAND
These natural-looking ecosystems can be located indoors and outside. They are used to provide a high level of polishing, removal of colloids and further denitrification.

EFFLUENT
Effluent parameters comply with the strictest environmental regulations

BLOWER AND AIR PIPES

EXCESS SLUDGE REMOVAL AND SLUDGE RECIRCULATION

OPEN AEROBIC REACTORS II-IV
Depending on the quality of the wastewater stream biological nitrification takes place in the consecutive aerobic stages. As the wastewater flows through each stage, its strength is reduced and higher organisms take part in the treatment process. In addition to plants, animals such as snails, clams, crabs and fish can be found in the tanks towards the end of the treatment line.

ANoxic REACTOR
For pretreatment and nitrogen removal via denitrification in tertiary treatment.
If We Were To Dream?
If We Were To Dream?
Green Roofs

Thermal Village Blumau

ASIC Southwest Regional Conference
Green Roofs

“Waldspirale" Darmstadt, Germ

ASIC Southwest Regional Conference
Green Roofs

RCCL Solstice Lawn Club

ASIC Southwest Regional Conference
Rooftop Urban Agriculture

Brooklyn Grange, New York City
Green Walls

One Park Central, Sidney
Bio-Lungs

Siam Paragon Center, Bangkok Thailand
Vertical Forests

Bosco Verticale, Milan
Vertical Greenhouses

EDDIT Tower Singapore
Vertical Farming

Sky Green Vertical Farms

ASIC Southwest Regional Conference
Bio-Climatic Buildings

Eco-Cybernetic City
Bio-Climatic Buildings

Fog Tower, Chile

ASIC Southwest Regional Conference
Building Integrated Vegetation

Hundertwasser House, Austria
Convergence of Technologies
Self Healing Materials
Lisbon based e-studio has developed an organic concrete. This concrete has a permeable surface which allows plants to grow out of it. Taking advantage of concrete’s capacity to trap water and retain humidity, the material works as a battery releasing water, so the substance can nourish plants even during a dry spell. The organic concrete makes it possible to create permeable living surfaces, allowing architects to incorporate a bit of greenery directly into their designs and reintroducing a natural component on urban public spaces.
Water Harvesting & Treatment Facades

ASIC Southwest Regional Conference
Will bioluminescent trees replace streetlights?
Robotic Bees to Pollinate Monsanto Crops

ASIC Southwest Regional Conference
Digital Data Successfully Merged With Biological DNA
Algae Bioreactor

El Paso, Texas

ASIC Southwest Regional Conference
Cities of the Future: Built By Drones and Bacteria

ASIC Southwest Regional Conference
Nature is Not Waiting for Us
Architecture’s Search for this Aesthetic
Restorative Urban Environments
The Living Bridges of Cherrapunji

ASIC Southwest Regional Conference
“The battle for life on earth will be won or lost in cities.”

United Nations 2008
A New Paradigm Shift

ASIC Southwest Regional Conference
A Better Paradigm Shift

ASIC Southwest Regional Conference
Prepare for a Radical Paradigm Shift

ASIC Southwest Regional Conference
“Design is the most under-utilized resource for solving environmental problems.”
Designing Water Harvesting to Augment Irrigation in the Arid Southwest
Southwest Water problems....

- Drought
- Groundwater depletion
- Flashy flood peaks
- Need to deflect stormwater
- Urban heat island effect

http://www.urban-climate-energy.com/urbanHeatIsland.htm
Irrigation & landscape issues....

- High evaporation rates – need on-going irrigation
- Erosion in big storms
- Soils salt up
- Many landscapes deflect water

Average Monthly Rainfall vs Pan Evaporation, Tucson, Arizona

- Pan Evaporation (Oregon Climate) (Services)
- Rainfall (National Weather Service)
The Solution...
Capture rainfall
Use is beneficially

1. There’s lots of it in urban areas
2. It falls where you need it
3. Plants like low salt and high nitrogen
4. Save $$$ getting rid of stormwater
5. Save $$$ over-irrigating (use Smart Controllers)
6. Its FREE
PASSIVE rainwater harvesting
(its not just about tanks...)

Shape the earth to collect and store water in the soil
Basins
Basins
Swales
Gravel-filled drains
Curb cuts
Weirs/Grade control structures
Porous pavement
Infiltration Basins, LID & GI projects
ACTIVE rainwater harvesting

*Capture rainwater in a tank*
*Store it for later beneficial use*
Above-ground tanks
Below-ground tanks
How do you design it?

Principles used in Rainwater harvesting design
Start harvesting at the top of the watershed
Capture water in multiple small catchments throughout the watershed
Collect, slow and infiltrate the water

Poinciana Road, Tucson, photo by Akhila Graham
Raise roads, sidewalks and paths; lower adjacent planting areas
Prepare for overflow
Mulch to reduce evaporation
Plant appropriate vegetation
Design for many functions: shade, clean stormwater, reduce runoff
How much water can you harvest?

The catchment-canopy-area ratio approach
Example: Use of catchment-to-canopy-area ratios

From: Guide to Assessing Rainwater and Stormwater Harvesting Potential to Meet Multiple Challenges and Provide Multiple Benefits

A project funded by U.S. Bureau of Reclamation
Landscape Conservation Cooperative
WaterSMART Program

Conducted by University of Arizona Water Resources Research Center, with input from Technical Advisory Committee, Water Harvesting and Landscape Consultants, and Regional Water Providers
SW desert average annual rainfall
Step 1. Graph average monthly rainfall

EXAMPLE: Tucson, Arizona
Annual average rainfall: 12 inches/year
Step 2. Graph 50% less rain/month to take into account variability & high/low rain events

Comparison of average monthly rainfall to "Effective" monthly rainfall for water harvesting (inches)

Tucson, AZ: Effective rainfall = 6 inches/year
Step 3. Graph low-water-use plant water demand

Low water use plant demand, Tucson, AZ. (inches)

Tucson, AZ, Low-water-use plant demand = 20 inches/year
Step 4. Compare low-water-use plant water demand to effective rainfall

Tucson, AZ, Low-water-use plant demand = 20 inches/year; Effective rainfall = 6 inches/year
Example
catchment-to-canopy-area ratios

3:1 ratio of catchment-area (gray) to tree canopy-area (green)

7:1 ratio of catchment-area (gray) to tree canopy-area (green)

NOTE: For typical urban sites, catchment areas include roofs, sidewalks, parking lots, patios, driveways, etc. plus rain falling on the land under the plant canopy
Step 5. Select effective catchment-to-canopy area ratio for the site

Tucson, AZ, Catchment-to-canopy-area ratio of 3:1 meets plant water demand 8 months/year
Example: How to select effective catchment-to-canopy-area ratios

**Example:**
- **Semi-arid area >10” PPT/YR,**
  - 3:1 ratio meets plant demand 8 months/yr

**Example:**
- **Arid area <10” PPT/YR,**
  - 7:1 ratio meets plant demand 8 months/yr
Example: Catchment-to-canopy area ratios at multifamily residential sites

3:1 catchment ratio

7:1 catchment ratio
Multifamily Sites

Water harvesting-based landscape at multifamily site, Tucson, AZ

Standard landscape at adjacent multifamily site, Tucson, AZ
Example: Catchment-to-canopy area ratios for commercial sector

3:1 CATCHMENT RATIO

7:1 CATCHMENT RATIO
Commercial parking lot redesigned and re-graded to harvest water, Tucson, AZ.
Example: Catchment-to-canopy area ratios for street rights-of-way

3:1 CATCHMENT RATIO

7:1 CATCHMENT RATIO
Public right-of-way

Lancaster Residence
public right-of-way
Tucson, Arizona
Basic components of Water Harvesting Plans

Who should be involved in planning?
RAINWATER HARVESTING PLAN ELEMENTS
Design and implementation team

Coordination is key

☑️ Developer
☑️ Building architect
☑️ Drainage/stormwater engineer
☑️ Landscape architect
☑️ Construction manager
☑️ Grader operators
☑️ Landscape installers
☑️ Irrigation installers
☑️ OTHERS?
Creative Water Harvesting
Richard Restuccia
BUILDING YOUR BRAND USING DIGITAL MEDIA

Presented by Richard Restuccia V.P. Jain Irrigation
AGENDA

WHY DIGITAL NOW
OVERALL STRATEGY
AWESOME PLACES TO START
A FEW EXAMPLES
“67% of marketers think marketing has changed more in the past two years than the previous fifty, and less than half of digital marketers feel highly proficient in their field.” - Adobe Systems 2013
Abe Hagenston, 42, is a homeless man living in Detroit who accepts donations via credit card. He also has a website where people can hire him for odd jobs. (Photo courtesy of WDIV-TV)
WHAT ARE YOUR DIGITAL MEDIA GOALS?

- Company/Agency Branding (Marketing)
- Information/Content
  - Distribution (Creation)
  - Education (Gathering/Sharing)
- Recruitment (to find or to be found)
- Sales/Lead Generation
- Other Goals
SIMPLE PLAN

SOCIAL MEDIA Marketing Plan

Choose your networks
Fill out your profiles
Find your voice & tone
Pick a posting strategy
Analyze and test
Automate and engage
What is LinkedIn?

World’s largest professional network with over 161,238,345 million members and growing rapidly.

2 billion member updates each week

LinkedIn connects you to your trusted contacts and helps you exchange knowledge, ideas, and opportunities with a broader network of irrigation professionals.
• Why Use LinkedIn?
• LinkedIn helps locate and **foster professional relationships** with landscape professionals.
• Since over 400 million businesspeople use LinkedIn, having a presence, a good reputation, and easy accessibility will **attract and inform followers**.
• LinkedIn is where the largest audience of influential irrigation professionals virtually congregate. When you **engage** this social media site you will improve:
  • **Professional Visibility, Connectability and Credibility**
• Never miss a chance to connect
  • 1700 1\textsuperscript{st} connections
  • 768,000 2\textsuperscript{nd} connections

• Never make a cold call again

• Get past the gate keeper with InMail
  • Paid accounts
  • 50 for Bus plan
  • Other than 1\textsuperscript{st} connections
  • Roll-over
• A smarter way to search
• Find people by company, location, key word
• Save your search and get weekly report
• Learn what is happening in your prospects companies

• Follow companies LinkedIn Page

Jain is a fully integrated global food/plant production company recognized by Harvard Business to be one of five global sustainability champions, and the G20 for lifting people out of poverty. Our irrigation manufacturing capabilities include everything from behind the pump to the flush valve at the end of the...
• Groups
• The number one reason to use LinkedIn
  • Learn about the irrigation industry
  • Opportunity to see more about prospect
  • Post and comment
• ASLA – 24K members
• Irrigation Association – 9K members
• CA Landscape Contractors – 4K members
• American Water Works – 37K members
• Landscape – 17K members
• Photo (helps people know which 1 of 246 Russell Clarks)
• Headline (what do you do...not your title)
• Summary (why do you do what you do w/ personal touch)
• Projects & Publications
• Experience (summary statement or 3 accomplishments)
• Education
• Websites
First Impression – Headline, Pic & Summary

Alan Harris
Water Scribe, Landscape Architect and Director of Sales Operations
Greater Atlanta Area | Facilities Services

Current: ValleyCrest Companies
Previous: ValleyCrest Companies, TruGreen LandCare, Lifescapes
Education: The University of Georgia

Improve your profile

www.linkedin.com/in/alanharris/
Sara (Hartmann) Castle
Developing professional relationships while driving property value through landscape solutions
Washington D.C. Metro Area | Commercial Real Estate

Current: ValleyCrest Companies
Previous: Teach for America, University of Florida
Education: University of Florida

Send a message

500+ connections
Summary

With over 30 years in the Green Industry I bring a diverse understanding of Design, Installation and Sustainable Solutions in Maintenance to the ValleyCrest teams and customers with whom I work. I enjoy sharing my knowledge and experience to drive successful solutions and help others solve problems.

Working at ValleyCrest enables me to work with a great local teams and be a one-stop solution for our customers’ landscape needs. I enjoy working with a wide range of customers—from resorts and retail centers to corporate campuses, public spaces and homeowners associations. ValleyCrest has a vision for great landscapes, a passion for outstanding customer service and the expertise to offer the most comprehensive services from turf to trees and from irrigation to seasonal color displays.

To learn more how we can help you with custom landscape and irrigation management solutions contact me at aharris@ValleyCrest.com or facebook.com/waterbloggers. On the weekends you can find me on the tennis court when not recovering from knee surgeries or sprained ankles.

Specialties: Expertise in Leadership, Water Management, Landscape Architecture, Social Media, Sales Management, Business Development, Sales Operations and Client Services
Twitter connects users to the latest stories, ideas, opinions and news about what they find interesting.

Completely customized news source with all the headlines you care about from “reporters” you trust.

To your customers and followers, you are that reporter. You tell them what’s important.
TRIVIA QUESTION #1

How many Twitter users are there in the U.S. today?

• A: 65 Million
• Twitter connects businesses to customers in real time
  • quickly share information
  • gather market intelligence and feedback
  • build relationships with customers, partners and influencers
• The fastest, simplest way to stay close to everything you care about.
TRIVIA QUESTION #1

What is the percentage of verified Twitter accounts that are journalists?

- **A: 25%**
Michelle Russ @greenthumbqueen · Mar 24
Teach a man to fish.. What a great trip! Crazy to think "Drip irrigation" can change lives. #DripIrrigation #Charity

Jain Irrigation USA @JainsUSA
Our water charity trip to the Bateyes of the Dominican Republic jainsusa.com/water+charity
WHAT MAKES A GREAT TWEET

• Have a personality
• Keep content interesting, frequent, and relevant
• It's hard to understand abbreviations, keep it simple & brief
• Create solutions
• Ask questions
• Use photos
TWITTER BEST PRACTICES

• Be part of the conversation
• Promote other users
• Keep up with it
• Create a tweet bank
• Thank you and questions
• Richard Restuccia
• 858 952-6038
• Rrestuccia@jainsusa.com
Carol Ward-Morris
Ongoing Drought & Looming Colorado River Shortage: Managing to Avoid Crisis

Carol M. Ward-Morris, Assistant Director
Arizona Municipal Water Users Association
Colorado River Basin
"More area in the West has persistently been in drought during the past 15 years than in any other 15-year period since the 1150s and 1160s."  -- bioclimatologist Park Williams
As Lake Mead Levels Drop, The West Braces For Bigger Drought Impact

NPR, April 17, 2015

“Just to see the rings around it, it’s just... kind of scary, you know.”
Lake Mead sinks to record low, risking water shortage

AZ Republic, June 24, 2015

“This is the check engine light.”
‘Historically dry’ February could lead to first-ever shortage declaration at Lake Mead


photo: David Becker, Las Vegas Review-Journal
# Probability of Colorado River Shortage

<table>
<thead>
<tr>
<th>Probability of any level of shortage (Mead ≤ 1,075 ft.)</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; level shortage (Mead ≤ 1,075 and ≥1,050 ft)</td>
<td>0</td>
<td>37</td>
<td>49</td>
<td>41</td>
<td>35</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; level shortage (Mead &lt;1,050 and ≥1,025 ft)</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; level shortage (Mead &lt;1,025)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

IMPACTED STATES
Tiers 1–3 of Shortage

Tier 1 13,000 AF (4%)
Tier 2 17,000 AF (6%)
Tier 3 20,000 AF (7%)

CA
NORMAL ENTITLEMENT
4.4 MAF

NV
NORMAL ENTITLEMENT
0.3 MAF

AZ
NORMAL ENTITLEMENT
2.8 MAF

Tier 1 320,000 AF (11%)
Tier 2 400,000 AF (14%)
Tier 3 480,000 AF (17%)

AZ AFFECTED MOST
CAP ABSORBS ENTIRE CUT FOR THE STATE

Tier 1 50,000 AF (3%)
Tier 2 70,000 AF (5%)
Tier 3 125,000 AF (8%)

LAKE MEAD
(MAP NOT TO SCALE)

REDUCTION TO CAP SUPPLY:
Tier 1 20%
Tier 2 25%
Tier 3 30%

Source: CAP
Water, 2015, California: The no-good, very bad year – now, 'pray for rain'

Los Angeles Times, Sept. 29, 2015
Unyielding California drought continues, despite “miracle March” deluge

Washington Post, March 11, 2016
Arizona stuck in prolonged drought but sees no California-style restrictions

Associated Press, June 7, 2015

photo: C. Ward-Morris
Top 10 Extreme Environments

#1: Tucson, Arizona

NationalGeographic.com
The SRP System
The CAP System
AMWUA Member Supply Portfolio

- Reclaimed: 5%
- Groundwater: 7%
- CAP: 37%
- SRP: 51%

Source: AMWUA
Conservation Requirements
Arizona

Water Use, Population and Economic Growth (1957 – 2013)

Source: ADWR
City of Phoenix

Gallons per Capita per Day (GPCD)
Changing Landscapes

City of Phoenix
Relative Water Use by Quarter Section

Source: City of Phoenix
Recycling, Underground Storage, Drought Plans

Palo Verde Nuclear Generating Station
Photo: APS

Tonopah Desert Recharge Project
Photo: City of Glendale

Drought Management Plan Figure
City of Scottsdale
Drought Management

photo: Kenne Turner, kenne.turner.com
Arizona’s Water Supply Sustainability
COLORADO RIVER
LOWER BASIN
STRUCTURAL DEFICIT

DIVERSEIONS ARE:
CA - 4.4 MAF
NV - 0.3 MAF
AZ - 2.8 MAF
MEXICO - 1.5 MAF

LAKE MEAD
DROPS 12 FEET PER YEAR EVEN IN NORMAL INFLOWS BECAUSE CURRENT USE EXCEEDS AVAILABLE SUPPLY.

TOTAL
9 MAF
ONLY 8.23 MAF RELEASED ANNUALLY
FROM LAKE POWELL

THE RESULTING DEFICIT MUST BE ADDRESSED TO PROTECT THE RELIABILITY OF THE COLORADO RIVER SYSTEM

Source: CAP
Addressing the Challenges on the Colorado River
Water Reliability for A Desert Community

Fernando Molina
Tucson Water
April 8, 2016
A Series of Investments to Ensure Tucson’s Water Future
The Five Elements of Water Reliability

**Water Supply**

- Develop new supplies to accommodate growth
- 50 Year Water Plan
- Limit the use of non-renewable resources
- Focus on use of renewable water supplies
Central Avra Valley Recharge and Recovery Program
Southern Avra Valley Recharge and Recovery Program
The Five Elements of Water Reliability

**Water Quality**

- Water quality must match the use
- Meet or exceed water quality standards
The Five Elements of Water Reliability

Maintenance and Infrastructure

- 4700 miles of pipe
- 60 Reservoirs
- 85,000 Valves
- 20,000+ Fire Hydrants
- 244,000 Services
Infrastructure
The Five Elements of Water Reliability

Efficiency and Sustainability

- Water Use Efficiency
- Sustainability
- Organizational Efficiency
Transition to Renewable Water Supplies

Water Production for TW Service Area (Acre-Feet)

- Groundwater
- CAP
- TARP
- Reclaimed Water

Water Use:
- Total Potable Water Use at 1985 Level
- Groundwater Use at 1945 Level

Year:
- 1940
- 1950
- 1960
- 1970
- 1980
- 1990
- 2000
- 2010
- 2015

Legend:
- Groundwater
- CAP
- TARP
- Reclaimed Water
Tucson Water Service Area GPCD Trends 2000-2015

- Total (Potable + Reclaimed) 130 GPCD
- Total Potable 117 GPCD
- Residential Potable 81 GPCD
1970s Water Crisis

- Growth in 1940s – 1970’s infrastructure investment
- Unable to meet demands during peak use periods
- Voluntary conservation, rate structure changes, political fallout
- Establishment of Beat the Peak Program
1970’s Tucson Landscapes
1970’s Tucson Landscapes
Beat the Peak Conservation Program

- Initiated in 1977

- Community Education

- Promotion of Desert Landscaping and “Trickle Irrigation”
1980’s / Groundwater Management Act

• Conservation requirements on users

• Tucson requirement calculation included reductions achieved in 1970’s.

• Still a groundwater system

• Beat the Peak continues
1990’s

- Development of Reclaimed Water System
- Initial attempt of CAP use
- Rates, Education & Ordinances to achieve conservation
- Xeriscape Ordinance for new Commercial Construction
- Establishment of Water Waste Ordinance
Irrigation Management Program

- Established LOW4 Program to conduct water audits at Commercial sites

- Contacted 300 sites
- Heard back from 150
- Scheduled with 75
- Pre-visit culled down to 35 – 40 audits
- Average DU approx. 27%
Lessons Learned

- Low DU’s & lack of groundskeeper/maintenance staff knowledge

- Transition to Education Program

- ADWR Grant / TUSD

- Follow up Audits / Decrease in DU

- ET-Based irrigation strategy connected to irrigation system efficiency
2000’s

- Re-Introduction of CAP water
- Water use patterns continue to change
- Peaking no longer an issue
- Transition from *Beat the Peak* to *Be Water Smart*
- Efficiency Rebates (2011)
Irrigation Efficiency Program

Procedures / Findings
- Pre & Post Audits Required

- 45% avg DU Pre-Inspection
  64% avg DU Post-Inspection

- 39% EU Pre-Inspection
  82% EU Post-Inspection

- Contractors did not understand DU and how to improve
Irrigation Efficiency Program Revisions

- Payout Capped at $10,000
  - Initially 1/3 cost of materials
  - Revised to ½ cost materials & labor

- Continue with Pre and Post Audit Requirement

- More prescriptive recommendations

- Rebate based on completed upgrades:
  - Sprinkler head adjustments
  - Move/add heads
  - Correct nozzles
  - Rain/soil moisture sensors
  - Weather based controller
  - Dedicated irrigation meter
  - Training
Sample of Commercial Irrigation Meters: 2012 to 2015

- Meter 1
- Meter 2
- Meter 3
- Meter 4
- Meter 5
- All 5 Meters

CCF

Greywater and Rainwater (RWH) Harvesting

2008
- Commercial RWH Ordinance
- Residential Greywater Ordinance

2011
Residential Greywater Program
  - Up to $1000 Rebate

2012
Residential Rainwater Harvesting Rebate
  - Up to $2000 Rebate
Commercial Rainwater Harvesting Ordinance

Ordinance Requirements:
- 50% of Landscape Water Requirement met through RWH practices
- Develop a landscape water budget
- Best available Practices/Technologies
- Monitoring and Reporting requirements
- Demonstration Projects
Residential Rainwater Harvesting Rebate Program

- Two levels of Participation:
  - Passive: Up to $500
  - Active: Up to $2000
- Must attend workshop
- Modified in 2015 to include Small Commercial Customers and Curb Cuts
- Approximately 900 rebates issued
Successful HET Program

Low Income Program Impacts:
Participants whose Invoice was in 2011
Water Use From 2009 to July 2014

- Participants
- All Single Family
2012 Participant Analysis

Water Harvesting Participant Usage and Control Group Usage
2009 to July 2015 for Participants who purchased a System in 2012

- rain
- Same Customer
- High Use Control
- All Single Family

CUI/Inches

Months

2012 Purchase Year
Drought and Tucson Water

- Currently storing almost 50% more than we use annually (144,000 af CAP allocation; use ~100,000af)

- Demand is down & continues to fall
  - 25% decrease since 2000
  - In 2014: 124 total gpcd and 88 residential gpcd

- **Tucson has a Drought Preparedness & Response Plan**
Stages of Drought Awareness

• **Stage One: Awareness**
  – Observed since 2007
  – City of Tucson Facility Audits required
  – Modifications & audits (facility, voluntary)

• **Stage Two: Shortage on the River**
  – Mandatory audits at facilities using more than 320ccf/month
  – *May* implement irrigation restrictions
  – Request conservation, self-audits, address non-essential uses
Stages of Drought Awareness

• **Stage Three: CAP Reduction**
  – Continue Stage One & Two
  – No operations of fountains at CII, multi-family sites
  – Restrictions on irrigation & washing paved areas
  – Interior efficiency retrofit requirements

• **Stage Four: Severe Cutbacks**
  – Implement City Emergency Water Conservation Ordinance
  – Restriction of non-essential outdoor water use, public misting systems
  – Water upon request
  – No filling of swimming pools, other exterior water features
  – Cars washed at recycle water facilities only—except emergency vehicles
**Potable Water Use - Projection to 2050 with Shortage**

**Volume (Acre-Feet)**

- **Year**

**Key Categories**

- **CAP Usage**
- **Long Term Storage**
- **Combination of Renewable and Finite Water Supplies**
- **Banked Colorado River Water**

**Graph Details**

- GPCD = 127

The graph illustrates the projection of potable water use from 2000 to 2050, accounting for both short-term and long-term storage options, as well as the combination of renewable and finite water supplies. A question mark is indicated near 2030, suggesting uncertainty or a significant change in projections for that year.
Ensuring Our Water Future: Indirect Potable Reuse

- Unused Reclaimed Water added to the drinking water supply
- Technology can create the highest quality water
- Sustainable – Supply renews and grows
Benefits of Using Recycled Water

- Local Control
- Significant investments in water and infrastructure
- Maximize use of existing infrastructure
- Buffers community from drought
- Supports economic development
- Reflects community stewardship of water resources
Conclusions

- Water will only become more expensive over time
- Rainwater harvesting does not appear to impact demands; equity issues need to be addressed
- Green infrastructure is critical to a sustainability effort
- Irrigation management requires ongoing educational effort

Don’t let the Water Waste Monster Bite You!
Questions or Comments?
Rainwater Harvesting Rebate Program

What the rainwater harvesting incentives program will **NOT** cover:

- imported soil to create passive rain garden practices
- purchase and delivery of gravel or decomposed granite (also known as DG or 1/4 minus)
- purchase or installation of pumps or associated controls, irrigation systems, or backflow prevention devices
- purchase or installation of landscaping materials such as plants, edging, decorative gravel, etc.
- installing, raising, or improving a driveway and removing concrete, asphalt, etc.
- purchase of tools such as shovels, rakes, drill bits, garden hoses, etc.
- labor completed by owner, neighbor, friend, or handyman
Payback assuming water collected was a new source:

- One 50 gallon rain barrel filled five times collects 250 gallons annually – resulting in a $1.24 value based on current water rates
- One 865 gallon cistern filled five times collects 4,325 gallons annually – resulting in a $21.45 value based on current water rates
- One 2,825 gallon cistern filled five times collects 14,125 gallons annually – resulting in a $70.06 value based on current water rates

60+ year payback?
## 2013-2014: Cost per CCF

<table>
<thead>
<tr>
<th></th>
<th>Expenditure</th>
<th>Saved Water (Ccf)</th>
<th>Cost per Ccf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Family HET</td>
<td>$202,160</td>
<td>24,938</td>
<td>$8.11</td>
</tr>
<tr>
<td>Multi-Family HET</td>
<td>$490,506</td>
<td>49,076</td>
<td>$9.99</td>
</tr>
<tr>
<td>Commercial HET</td>
<td>$28,886</td>
<td>4,932</td>
<td>$5.86</td>
</tr>
<tr>
<td>Low-Income HET</td>
<td>$313,116</td>
<td>9,988</td>
<td>$31.34</td>
</tr>
<tr>
<td>High-Efficiency Urinal</td>
<td>$52,400</td>
<td>2,582</td>
<td>$20.29</td>
</tr>
<tr>
<td>Gray Water</td>
<td>$4,678</td>
<td>174</td>
<td>$26.89</td>
</tr>
<tr>
<td>Rainwater Harvesting</td>
<td>$354,538</td>
<td>0</td>
<td>$354,538.00</td>
</tr>
<tr>
<td>Irrigation Upgrade</td>
<td>$83,676</td>
<td>3,074</td>
<td>$27.22</td>
</tr>
</tbody>
</table>
Drought Management in the West

Issues Facing California Consultants from Drought Legislation

Steve Hohl, ASIC
GOAL

...To explain how legislation and codes have changed in California to improve water use efficiency in the irrigation industry...

...To promote a call to action for our profession to get involved to make viable solutions...
CURRENT STATUS

• EO B-29-15
  – Restriction of water allotment to new landscapes
  – Mandatory 25% reduction of water use with higher values based on per capita use
  – 50 M sq. ft. turf replacement
  – Prohibit irrigation of turf medians with potable water
  – Requirement of new landscapes to comply with CAL-GREEN
  – Update the MWELO to increase water efficiency standards through more efficient irrigation, greywater usage, onsite storm water capture and limiting turf use
HISTORY OF MWELO

• 2004
  – AB2717 passed requesting California Urban Water Conservation Council (CUWCC) to start a task force of public and private agencies to evaluate proposals to improve water use efficiency in new and existing urban landscapes. Updates to 1990 Model Water Efficient Landscape Ordinance (MWELO)
History of MWELO

• 2006 Water Conservation in Landscaping Act
  – AB1881
  – Required update to MWELO to take effect in 2010
  – Local agencies must update ‘at least as effective’ or adopt State model
  – Requires adoption of performance standards, labeling requirements for irrigation equipment to reduce wasteful consumption of energy or water
    • Controllers
    • Moisture sensors
    • Emission devices
    • Valves
MWELO

- 2010 – All agencies in California adopt local ‘at least as effective’ MWELO
- 2015 – Executive Order B-29-15 in April required an update to the MWELO by January 2016
THOUGHTS

Lack of professionalism in design, install and maintenance
THOUGHTS

Some would ban irrigation if permitted

Public perception magnified due to drought

Photo Credit: Thomas Boyd
Applicability

- 500 sq. ft. (2,500 prior) for public and private development
- 500 sq. ft. (5,000 prior) for residential projects
- 2,500 sq. ft. for rehabilitated landscapes
- Requiring a permit

Meeting the applicability requires submission of Landscape Document Package
MWELO 2015

Landscape Document Package

– Water Efficient Landscape Worksheet
  • Maximum Applied Water Allowance
  • Estimated Total Water Use
– Soil Management Report
– Landscape Design Plan
– Irrigation Plan
– Grading Design Plan
– Certificate of Completion
– Scheduling
– Maintenance Schedule
– Irrigation Audit
– Minimum Irrigation Efficiency

Photo Credit: Austin Pond Doctor
Maximum Available Water Allotment (MAWA)

\[ MAWA = (ET_o \times 0.62) \left[ (ETAF \times LA) + (1 - ETAF) \times SLA \right] \]

Whereas:

- \( Eto \): Reference ET (inches per year)
- 0.62: Conversion factor to gallons
- ETAF: ET adjustment Factor (0.45 for Commercial, 0.55 for Residential)
- LA: Landscape Area (Sq. ft.)
- SLA: Special Landscape Area (Recycled water, Recreational area, Edible gardens)

“Recreational area” means areas designated for active play, recreation or public assembly in parks, sports fields, picnic grounds, amphitheaters or golf course tees, fairways, roughs, surrounds and greens.
Estimated Total Water Allotment (ETWU)

\[ ETWU = (ETo \times 0.62) \sum \frac{LA(h) \times PF(h)}{IE(h)} + SLA \]

Whereas:

- \( Eto \) = Reference ET (inches per year)
- \( 0.62 \) = Conversion factor to gallons
- \( LA(h) \) = Hydrozone Landscape Area (Sq. ft.)
- \( PF(h) \) = Hydrozone Plant Factor based on WUCOLS or other source
- \( IE(h) \) = Hydrozone Irrigation Efficiency
- \( SLA \) = Special Landscape Area*

*All SLA areas automatically designate an ETAF of 1.0

Photo Credit: Donna Williams Blog, www.donnawilliams.net
Increased Irrigation Efficiency based on DUlh and Irrigation Management Efficiency (IME) of 0.90

- Overhead spray = 0.83 x .90 = 0.75
- Drip = 0.90 x 0.90 = 0.81

ETAF (PF / IE)= .45 for commercial
- 70% low with drip / 30% moderate planting with drip
- 85% low with drip / 15% warm season turf with HE spray
- 90% low with drip / 10% cool season turf with HE spray

ETAF (PF / IE)= .55 for residential
- 30% low with drip / 70% moderate planting with drip
- 65% low with drip / 35% warm season turf with HE spray
- 80% low with drip / 20% cool season turf with HE spray
# Mwele Water Usage Worksheet

## Water Meter 1 / Controller A

**City or Zone:** Anaheim  
**Reference Evapotranspiration (ETo):** 16.00  
**Landscape Type:** Non-Residential

### Regular Landscape Areas

<table>
<thead>
<tr>
<th>Hydrozone No.</th>
<th>Landscape Area (sq. ft.)</th>
<th>Plant Type</th>
<th>Plant Factor (PF)</th>
<th>Irrigation Type</th>
<th>ET Adjustment Factor (STAF)</th>
<th>Estimated Water Use (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,500</td>
<td>Shrub - Low Water Use</td>
<td>0.2</td>
<td>Inline Drip</td>
<td>81%</td>
<td>15,299</td>
</tr>
<tr>
<td>2</td>
<td>252</td>
<td>Turf - High Season</td>
<td>0.0</td>
<td>Mist Spray</td>
<td>72%</td>
<td>2,873</td>
</tr>
<tr>
<td>3</td>
<td>4,123</td>
<td>Shrub - Low Water Use</td>
<td>0.2</td>
<td>Mist Rotary</td>
<td>78%</td>
<td>16,909</td>
</tr>
<tr>
<td>4</td>
<td>211</td>
<td>Shrub - Med Water Use</td>
<td>0.5</td>
<td>Inline Drip</td>
<td>81%</td>
<td>1,097</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Total (sq. ft.):** 6,698  
**Estimated Total Water Use (gallons):** 57,097

### Special Landscape Areas

<table>
<thead>
<tr>
<th>Type</th>
<th>Landscape Area (sq. ft.)</th>
<th>Plant Type</th>
<th>Plant Factor (PF)</th>
<th>Irrigation Type</th>
<th>ET Adjustment Factor (STAF)</th>
<th>Estimated Water Use (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycled Water</td>
<td>43,993</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,324,734</td>
</tr>
<tr>
<td>Corridor Garden</td>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,386,591</td>
</tr>
<tr>
<td>Urban Forest</td>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,417,786</td>
</tr>
</tbody>
</table>

**Total (sq. ft.):** 45,986  
**Estimated Total Water Use (gallons):** 1,324,734  
**Site-Wide Estimated Total Water Use (gallons):** 1,386,591  
**Maximum Applied Water Allowance (gallons):** 1,417,786

### Special Landscape Areas - Actual Water Use

<table>
<thead>
<tr>
<th>Hydrozone No.</th>
<th>Landscape Area (sq. ft.)</th>
<th>Plant Type</th>
<th>Plant Factor (PF)</th>
<th>Irrigation Type</th>
<th>Actual ET Adjustment Factor (STAF)</th>
<th>Actual Estimated Water Use (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>85,169</td>
<td>turf - warm season</td>
<td>0.8</td>
<td>rotor</td>
<td>70%</td>
<td>1,092,127</td>
</tr>
<tr>
<td>6</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>7</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>8</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>9</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>10</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>11</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>12</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>13</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>14</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Total SLA Area (sq. ft.):** 43,560  
**SLA Total Water Use (gallons):** 1,932,527  
**Total Standard Area (sq. ft.):** 6,486  
**Standard Landscape Water Use (gallons):** 57,097  
**Total Landscape Area (sq. ft.):** 50,046  
**Actual Total Water Use (gallons):** 1,932,527  
**Site-Wide Efficiency:** 74%  
**Site-Wide STAF:** 0.71  
**Maximum Allowable Water Alotment (gallons):** 1,417,786

---

**ETWS = N/A**  
**YES**
MWELO 2015

Landscape Design Plan

– Turf not permitted on slopes > 25%
– High water use plants not permitted in medians
– Water features considered as high water use hydrozone and included in ETWU
– Compost integrated at 4CY / 1,000 sq. ft. 6” deep
– Minimum 3” mulch
– Delineate all hydrozones
– Identify water use classification of plant palette
– Permeable non irrigated areas not considered in Landscape Area
Irrigation Design Plan

- Water meters for non-residential landscapes > 1,000 sq. ft.
- Water meters for residential landscapes > 5,000 sq. ft.
- ET or soil moisture based controllers
- Pressure regulator if static pressure > required dynamic
- Rain sensor
- Flow sensor on all non-residential systems and on residential systems > 5,000 sq. ft.
- Master valve on all projects
- Minimum DULQ > 0.65 or using protocol in ASABE/ICC 802-2014
Irrigation Design Plan

- In mulched areas, the use of low volume irrigation is required to maximize water infiltration into the root zone*
- Swing joints required
- Check valves
- Areas < 10 feet in any direction require subsurface irrigation or other means that produces no runoff or overspray
- Overhead irrigation not permitted within 24 inches of non-permeable surface
- Slopes > 25% limited to application rate < 0.75 inches per hour
- Trees shall be placed on separate valves – where feasible
- Identify the hydrozone and application rate on each valve
- “I have complied with the criteria of the ordinance and applied them accordingly for the efficient use of water in the irrigation design plan”
MWEO 2015

Certification of Completion

– As-built plan
– Hydrozone plan kept with controller
– Irrigation Schedule
– Maintenance Schedule
– Audit Report
  • Conducted by local agency or third party certified auditor.
  • Cannot be conducted by person who designed or installed landscape
  • 1 in 7 or 15% of Lots in large development
LOCAL VARIANCES

At Least as Effective

Variances include:

- Prohibit overhead spray on slopes
- No designation of recycled water as a SLA
- Setback distance from non-permeable landscape areas
- Timing charts (Peak ET schedule, monthly, volume per valve per month)
- Hydrozone charts in addition to schedules
- Definition of “Low Volume Irrigation”
- Irrigation Efficiencies

Many agencies lack staff and funding to implement and enforce new MWEO requirements

Confusion on plan review implementation due to subjective interpretation and lack of irrigation knowledge

Photo Credit: www.agindiscodiva.blogspot.com/2008_05_01_archive
WE ARE HERE...

– More creative use of planting
– Public acceptance will take time
– Creative search for water resource development
– Accountability of the installer and maintenance entity
– Tiered rate structures
– Penalties for over-use
– Public education
– Agency reporting
WE ARE HERE...

Photo Credit: The Metropolitan Water District of Southern California
http://bewaterwise.com/gardenspot.html
Population increase and limited water resource development require further tightening of potable water use in the landscape...

Projected California Population Growth

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>38,896,969</td>
</tr>
<tr>
<td>2020</td>
<td>40,619,346</td>
</tr>
<tr>
<td>2025</td>
<td>42,373,301</td>
</tr>
<tr>
<td>2030</td>
<td>44,085,600</td>
</tr>
<tr>
<td>2035</td>
<td>45,747,645</td>
</tr>
</tbody>
</table>

Source: California Department of Finance, Table P-1, Last accessed: January 28, 2016.
THE FUTURE?

– Decrease potable water use by 50%
– Further turf reduction
– Home inspection reports to include irrigation system
– Expansion of MWELO to existing landscape
– Water budget .80 ETAF with 55 GPD / Person
– Applicability
– Change the SLA to 0.80 ETAF
– All landscapes require a permit
ASIC worked with ASLA, BIA, IA and other organizations to collaborate our stakeholder responses to DWR.

Our goals to improve outdoor water use efficiency are in common, including the viable solutions offered to DWR.

We have a call to action to continue to keep the solutions at mid ground.

We need to have an active presence with policy makers.
Sierra Nevada Snowpack Grew During First Half of March, But Dry Spell Leaves Water Content Still below Average

SACRAMENTO – California’s statewide snowpack usually reaches its peak depth and water content each year around the first of April, after which the snow begins to melt as the sun’s path across the sky moves a little further north each day. Therefore, conditions today were just about as good as they’re going to get this year when the Department of Water Resources (DWR) conducted its media-oriented snow survey at Phillips Station in the Sierra Nevada east of Sacramento.

The same is true for the statewide snowpack, which some had expected to benefit more than it has from El Niño conditions. Statewide, water content of the mountain snowpack today is only 87 percent of the March 30 historical average.
QUESTIONS?
Another Way to Characterize Sprinkler Performance

Brent Mecham, Ed Norum
Simple irrigation
Challenging
Complex
Sprinkler interaction
Nozzle choices
Study at Cal Poly-Pomona

Distribution Uniformity of Multi-Stream-Rotating Nozzles Spaced Below Recommended Distance
Kumar, Green, Vis
Study: RMSMT nozzles

- Maximum spacing  HTH
- Spacing reduced 10%, nozzle unadjusted
- Spacing reduced 25%, nozzle unadjusted
- Spacing reduced 10%, nozzle adjusted
- Spacing reduced 25%, nozzle adjusted

10% = common design practice
25% = common maximum radius adjust
## Study Results--$DU_{lq}$

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nozzle A</th>
<th>Nozzle B</th>
<th>Nozzle C</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max HTH</td>
<td>0.58</td>
<td>0.58</td>
<td>0.45</td>
<td>0.54</td>
</tr>
<tr>
<td>-10% unadj.</td>
<td>0.64</td>
<td>0.65</td>
<td>0.57</td>
<td>0.62</td>
</tr>
<tr>
<td>-25% unadj.</td>
<td>0.59</td>
<td>0.78</td>
<td>0.62</td>
<td>0.66</td>
</tr>
<tr>
<td>-10% adjust.</td>
<td>0.81</td>
<td>0.76</td>
<td>0.52</td>
<td>0.70</td>
</tr>
<tr>
<td>-25% adjust.</td>
<td>0.75</td>
<td>0.74</td>
<td>0.67</td>
<td>0.72</td>
</tr>
<tr>
<td>Overall</td>
<td>0.68</td>
<td>0.71</td>
<td>0.56</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Average of four replications

Unadjusted = over spraying target area
Densograms

- Visual graphic showing water application
- Based on a single sprinkler profile
- Spacing arrangements
- Does not explain off-target application
- Does not explain jet interference
- Calculated potential $DU_{lq}$, SC, CU
# 7 nozzle  40 psi  Square Spacing

DU= .73  SC=1.6  

DU= .82  SC=1.2
#4, #7, #10  33’ oc square spacing

DU=66  SC=1.5  PR= .36”/hr avg.
(.18”/hr min, .69”/hr max.)
SWAT Testing Protocol

• Spray Head Nozzles Performance Characteristics 3.2
  – Individual nozzles and groups of nozzles
  – Spacing configurations
  – Operating pressures
  – Repeatability
  – Sprinkler operational efficiency
  – $DU_{lq}$

• Finalized April, 2015—ready for testing
Testing configurations
Controlled operating pressure

Catchment devices measure to 0.01 inches
Testing

• Consider:
  – Operating pressure
  – Overspray
  – Percolation (excess)
  – Median and Effective application rate
  – Sprinkler Operating Efficiency
  – $D_{u_{1q}}$ for comparison
OS = 0.1\% \quad PL = 42.7\% \quad \text{OE}_S = 57.2\% \quad \text{DU}_{lq} = 0.40
OS = 1.5%   PL = 10.4%   OES = 88.3%   DU_{\text{aq}} = .83
OS = 6.8%  PL = 15.3%  OE_S = 78.9%  DU_{iq} = 0.49
Sprinkler Operational Efficiency

\[
OS = \frac{\sum OS}{N(\bar{x}) + \sum OS}
\]

\[
PL = 1 - \left( \frac{\sum_{1st}^{75th} (n_1 + n_2 + n_3 \ldots \ldots n_i)}{\#(\bar{x})} \right)
\]

\[
OE_s = (1.0 - PL)(1.0 - OS) \times 100
\]
## Results-Spray Nozzle

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>Shape</th>
<th>psi</th>
<th>PR$_{avg}$</th>
<th>PR$_{effect}$</th>
<th>OS %</th>
<th>PL %</th>
<th>OE$_S$%</th>
<th>DU$_{iq}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>□</td>
<td>20</td>
<td>0.82</td>
<td>0.63</td>
<td>3.6</td>
<td>26.9</td>
<td>70.5</td>
<td>0.62</td>
</tr>
<tr>
<td>S</td>
<td>□</td>
<td>30</td>
<td>0.94</td>
<td>0.79</td>
<td>3.8</td>
<td>18.7</td>
<td>78.2</td>
<td>0.71</td>
</tr>
<tr>
<td>S</td>
<td>□</td>
<td>45</td>
<td>1.31</td>
<td>1.02</td>
<td>2.1</td>
<td>22.4</td>
<td>76.0</td>
<td>0.60</td>
</tr>
<tr>
<td>S</td>
<td>○</td>
<td>20</td>
<td>0.85</td>
<td>0.63</td>
<td>8.6</td>
<td>30.4</td>
<td>63.6</td>
<td>0.64</td>
</tr>
<tr>
<td>S</td>
<td>○</td>
<td>30</td>
<td>1.03</td>
<td>0.76</td>
<td>8.4</td>
<td>27.4</td>
<td>66.5</td>
<td>0.68</td>
</tr>
<tr>
<td>S</td>
<td>○</td>
<td>45</td>
<td>1.24</td>
<td>0.98</td>
<td>8.6</td>
<td>23.5</td>
<td>69.9</td>
<td>0.71</td>
</tr>
</tbody>
</table>

*Same nozzle and spacing, different operating pressures*
### Results - MS Rotating Nozzle

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>Shape</th>
<th>psi</th>
<th>PR$_{avg}$</th>
<th>PR$_{effect}$</th>
<th>OS %</th>
<th>PL %</th>
<th>OE$_S$%</th>
<th>DU$_{lq}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-1</td>
<td>![Image]</td>
<td>40</td>
<td>0.46</td>
<td>0.39</td>
<td>1.1</td>
<td>19.1</td>
<td>80.0</td>
<td>0.66</td>
</tr>
<tr>
<td>R-2</td>
<td>![Image]</td>
<td>40</td>
<td>0.60</td>
<td>0.54</td>
<td>1.5</td>
<td>10.4</td>
<td>88.3</td>
<td>0.83</td>
</tr>
<tr>
<td>R-3</td>
<td>![Image]</td>
<td>45</td>
<td>1.04</td>
<td>0.70</td>
<td>0.1</td>
<td>57.4</td>
<td>42.5</td>
<td>0.40</td>
</tr>
<tr>
<td>R-1</td>
<td>![Image]</td>
<td>40</td>
<td>0.48</td>
<td>0.37</td>
<td>1.8</td>
<td>27.0</td>
<td>71.7</td>
<td>0.51</td>
</tr>
<tr>
<td>R-2</td>
<td>![Image]</td>
<td>40</td>
<td>0.65</td>
<td>0.57</td>
<td>6.8</td>
<td>15.3</td>
<td>78.9</td>
<td>0.49</td>
</tr>
<tr>
<td>R-3</td>
<td>![Image]</td>
<td>45</td>
<td>1.35</td>
<td>0.88</td>
<td>6.0</td>
<td>36.6</td>
<td>59.6</td>
<td>0.53</td>
</tr>
</tbody>
</table>

3 different MS-rotating nozzles
In 2014 CIT was asked to develop a protocol useful in administering sprinkler rebate programs

• The protocol would be administered by third-party testing agencies to:
  – Pre-qualify turf sprinklers for rebate programs
  – Establish current “state-of-the-art”
  – Provide incentives for ongoing improvements
  – Unfortunately no test protocol existed that calculated sprinkler operational efficiency
Current sprinkler test method:

- NOT consistent with operational conditions
- Single head tested
- Computer simulation using multiple heads
- Makes no allowances for jet mechanical interference
Multiple sprinkler performance
Multiple sprinkler performance
Full scale irrigation set-up in CIT

• Sprinkler heads operated simultaneously
• Sprinkler heads operated individually
• Operational Efficiency calculated for each
Sprinkler Operation Test Setup
Phenomena of Jet Interference =
DU = 0.598

All sprinklers operated simultaneously
Non Interference = DU: 0.871

All sprinklers operated individually
Test

• Tests conducted by CIT
• Defined shape and spacing
• Manufacturers supply the nozzle best suited to the situation.
Testing configurations
## Results—Square

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>Shape</th>
<th>psi</th>
<th>PR\textsubscript{avg}</th>
<th>PR\textsubscript{effect}</th>
<th>OS %</th>
<th>PL %</th>
<th>OE\textsubscript{5} %</th>
<th>DU\textsubscript{Lq}</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td></td>
<td>30</td>
<td>1.62</td>
<td>1.38</td>
<td>1.0</td>
<td>20.1</td>
<td>79.1</td>
<td>0.74</td>
</tr>
<tr>
<td>#2</td>
<td></td>
<td>30</td>
<td>1.61</td>
<td>1.40</td>
<td>0.1</td>
<td>19.3</td>
<td>80.6</td>
<td>0.74</td>
</tr>
<tr>
<td>#3</td>
<td></td>
<td>40</td>
<td>0.61</td>
<td>0.56</td>
<td>6.2</td>
<td>12.7</td>
<td>81.9</td>
<td>0.79</td>
</tr>
<tr>
<td>#4</td>
<td></td>
<td>30</td>
<td>1.63</td>
<td>1.28</td>
<td>2.0</td>
<td>25.4</td>
<td>73.1</td>
<td>0.63</td>
</tr>
<tr>
<td>#5</td>
<td></td>
<td>30</td>
<td>1.25</td>
<td>1.09</td>
<td>0.9</td>
<td>21.2</td>
<td>78.1</td>
<td>0.65</td>
</tr>
<tr>
<td><strong>Avg</strong></td>
<td></td>
<td></td>
<td><strong>1.34</strong></td>
<td><strong>1.14</strong></td>
<td><strong>2.0</strong></td>
<td><strong>19.7</strong></td>
<td><strong>78.6</strong></td>
<td><strong>0.71</strong></td>
</tr>
</tbody>
</table>

Manufacturers recommended and supplied the nozzle to irrigate a square shape that is 30 ft. x 30 ft. in size.
## Results—Circular

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>Shape</th>
<th>psi</th>
<th>PR\textsubscript{avg}</th>
<th>PR\textsubscript{effect}</th>
<th>OS %</th>
<th>PL %</th>
<th>OE\textsubscript{s} %</th>
<th>DU\textsubscript{iq}</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td></td>
<td>30</td>
<td>1.75</td>
<td>1.47</td>
<td>7.0</td>
<td>24.2</td>
<td>70.5</td>
<td>.63</td>
</tr>
<tr>
<td>#2</td>
<td></td>
<td>30</td>
<td>1.86</td>
<td>1.40</td>
<td>0.2</td>
<td>33.6</td>
<td>66.3</td>
<td>.29</td>
</tr>
<tr>
<td>#3</td>
<td></td>
<td>40</td>
<td>0.64</td>
<td>0.49</td>
<td>6.0</td>
<td>27.6</td>
<td>67.9</td>
<td>.41</td>
</tr>
<tr>
<td>#4</td>
<td></td>
<td>30</td>
<td>0.90</td>
<td>0.73</td>
<td>1.1</td>
<td>30.8</td>
<td>68.4</td>
<td>.55</td>
</tr>
<tr>
<td>#5</td>
<td></td>
<td>30</td>
<td>1.82</td>
<td>1.45</td>
<td>10.0</td>
<td>23.6</td>
<td>68.7</td>
<td>.64</td>
</tr>
<tr>
<td>Avg</td>
<td></td>
<td></td>
<td>1.39</td>
<td>1.11</td>
<td>4.9</td>
<td>28.0</td>
<td>68.4</td>
<td>.50</td>
</tr>
</tbody>
</table>

Manufacturers recommended and supplied the nozzle to irrigate a circular shape that is 30 feet in diameter.
## Comparison—same nozzle

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>Shape</th>
<th>psi</th>
<th>PR$_{avg}$</th>
<th>PR$_{effect}$</th>
<th>OS %</th>
<th>PL %</th>
<th>OE$_S$ %</th>
<th>DU$_{Iq}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1-a</td>
<td>▢</td>
<td>30</td>
<td>1.62</td>
<td>1.38</td>
<td>1.0</td>
<td>20.1</td>
<td>79.1</td>
<td>0.74</td>
</tr>
<tr>
<td>#1-b</td>
<td>⊙</td>
<td>30</td>
<td>1.75</td>
<td>1.47</td>
<td>7.0</td>
<td>24.2</td>
<td>70.5</td>
<td>0.63</td>
</tr>
<tr>
<td>#1-c</td>
<td>⊙</td>
<td>30</td>
<td>1.86</td>
<td>1.40</td>
<td>0.2</td>
<td>33.6</td>
<td>66.3</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Same nozzle. Test #1-c is “fine-tuning” after test #1-b
What does this mean?

• Landscapes are irrigated by areas.
• Need to consider how zoning and piping can improve sprinkler performance.
Conclusions

• Curvilinear shapes are more difficult to irrigate efficiently.
• DU is one metric—
• Sprinkler operation efficiency (OE<sub>s</sub>) considers where is the water going.
• MS rotating nozzles create less interference of pattern.
• Keep water on target.
• Cycle & Soak is effective to deal with wind.
<table>
<thead>
<tr>
<th>Test #</th>
<th>Sprinkler ID</th>
<th>Shape</th>
<th>Pressure psi</th>
<th>PR avg. in./h</th>
<th>PR effective (75%)</th>
<th>DU_{eq}</th>
<th>SM</th>
<th>Effective PR PRavg/SM</th>
<th>Over spray Losses %</th>
<th>Deep Perc Losses %</th>
<th>Sprinkler Oper'l Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>SQ</td>
<td>20</td>
<td>0.818</td>
<td>0.63</td>
<td>0.62</td>
<td>1.30</td>
<td>0.630</td>
<td>3.6</td>
<td>26.9</td>
<td>70.5</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>Circle</td>
<td>20</td>
<td>0.849</td>
<td>0.631</td>
<td>0.64</td>
<td>1.28</td>
<td>0.664</td>
<td>8.6</td>
<td>30.4</td>
<td>63.6</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>SQ</td>
<td>30</td>
<td>0.944</td>
<td>0.793</td>
<td>0.71</td>
<td>1.21</td>
<td>0.778</td>
<td>3.8</td>
<td>18.7</td>
<td>78.2</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>Circle</td>
<td>30</td>
<td>1.026</td>
<td>0.76</td>
<td>0.68</td>
<td>1.24</td>
<td>0.828</td>
<td>8.4</td>
<td>27.4</td>
<td>66.5</td>
</tr>
<tr>
<td>5</td>
<td>A</td>
<td>SQ</td>
<td>45</td>
<td>1.312</td>
<td>1.015</td>
<td>0.60</td>
<td>1.32</td>
<td>0.997</td>
<td>2.1</td>
<td>22.4</td>
<td>76.0</td>
</tr>
<tr>
<td>6</td>
<td>A</td>
<td>Circle</td>
<td>45</td>
<td>1.244</td>
<td>0.981</td>
<td>0.71</td>
<td>1.21</td>
<td>1.028</td>
<td>8.6</td>
<td>23.5</td>
<td>69.9</td>
</tr>
<tr>
<td>7</td>
<td>B</td>
<td>SQ</td>
<td>30</td>
<td>1.676</td>
<td>1.298</td>
<td>0.60</td>
<td>1.32</td>
<td>1.274</td>
<td>1.3</td>
<td>27.0</td>
<td>72.1</td>
</tr>
<tr>
<td>8</td>
<td>B</td>
<td>Circle</td>
<td>30</td>
<td>1.635</td>
<td>1.343</td>
<td>0.60</td>
<td>1.32</td>
<td>1.243</td>
<td>10.8</td>
<td>27.5</td>
<td>64.7</td>
</tr>
<tr>
<td>9</td>
<td>C</td>
<td>SQ</td>
<td>40</td>
<td>0.458</td>
<td>0.391</td>
<td>0.66</td>
<td>1.26</td>
<td>0.365</td>
<td>1.1</td>
<td>19.1</td>
<td>80.0</td>
</tr>
<tr>
<td>10</td>
<td>C</td>
<td>Circle</td>
<td>40</td>
<td>0.481</td>
<td>0.368</td>
<td>0.51</td>
<td>1.42</td>
<td>0.340</td>
<td>1.8</td>
<td>27.0</td>
<td>71.7</td>
</tr>
<tr>
<td>11</td>
<td>D</td>
<td>SQ</td>
<td>40</td>
<td>0.597</td>
<td>0.541</td>
<td>0.83</td>
<td>1.11</td>
<td>0.536</td>
<td>1.5</td>
<td>10.4</td>
<td>88.3</td>
</tr>
<tr>
<td>12</td>
<td>D</td>
<td>Circle</td>
<td>40</td>
<td>0.653</td>
<td>0.568</td>
<td>0.49</td>
<td>1.44</td>
<td>0.453</td>
<td>6.8</td>
<td>15.3</td>
<td>78.9</td>
</tr>
<tr>
<td>13</td>
<td>E</td>
<td>SQ</td>
<td>45</td>
<td>1.041</td>
<td>0.7</td>
<td>0.40</td>
<td>1.56</td>
<td>0.666</td>
<td>0.1</td>
<td>42.7</td>
<td>57.2</td>
</tr>
<tr>
<td>14</td>
<td>E</td>
<td>Circle</td>
<td>45</td>
<td>1.347</td>
<td>0.884</td>
<td>0.53</td>
<td>1.39</td>
<td>0.967</td>
<td>6.0</td>
<td>36.6</td>
<td>59.6</td>
</tr>
<tr>
<td>PR_{avg}</td>
<td>PR effective</td>
<td>SM upper boundary</td>
<td>PR_{avg}/SOE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>--------------</td>
<td>-------------------</td>
<td>--------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ideal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>73.3</td>
<td>95.2</td>
<td>95.3</td>
<td>104.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70.7</td>
<td>95.1</td>
<td>90.3</td>
<td>111.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>63.6</td>
<td>75.7</td>
<td>77.1</td>
<td>81.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>58.5</td>
<td>78.9</td>
<td>72.4</td>
<td>87.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45.7</td>
<td>59.1</td>
<td>60.2</td>
<td>60.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48.2</td>
<td>61.2</td>
<td>58.4</td>
<td>69.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.8</td>
<td>46.2</td>
<td>47.1</td>
<td>49.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36.7</td>
<td>44.7</td>
<td>48.3</td>
<td>56.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>131.0</td>
<td>153.5</td>
<td>164.6</td>
<td>163.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>124.7</td>
<td>163.0</td>
<td>176.7</td>
<td>174.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100.5</td>
<td>110.9</td>
<td>111.9</td>
<td>113.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91.9</td>
<td>105.6</td>
<td>132.4</td>
<td>116.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>57.6</td>
<td>85.7</td>
<td>90.1</td>
<td>100.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44.5</td>
<td>67.9</td>
<td>62.0</td>
<td>74.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Thoughts

Questions
Douglas Macdonald
Certification Update
ASIC Strategic Plan – Adopted 4/26/10

Vision Statement

ASIC strives to represent the most experienced and responsible irrigation professionals in the world. Its members facilitate successful water resource management through design expertise, client advocacy, public service, education, accreditation, and the promotion of allied green industry partnerships.
Objective #1
Position/Brand ASIC as *the top-tier body* representing water resource development, design and management professionals with a commitment to environmental stewardship and the responsible use of water.
Tactic #3

Adopt an *optional certification program* that demonstrates stringent professional standards and expectations to the marketplace. The certification process will entail clear, unambiguous requirements.

- Time Frame: Immediate
- Resources: Board of Directors subcommittee and Staff
Recent History

• Discussions with membership - no progress...
• Board realization that we can’t do this on our own
  • Third-party assistance
  • Experienced entity – Irrigation Association
    • Proposal submitted to ASIC at BOD Meeting November 2014
Certification Program requires process

Design & implementation requires:

• Strong organizational commitment

• Financial investment to launch and maintain the program

• Expertise of many experienced professionals to help develop program
2015 Proposal Background

• Certification provides proof that an individual has mastered knowledge, skills and abilities to perform a specific job and requires:
  • Establishment of clear goals up-front
  • Market research and analysis
  • Determine mission, goals and objectives for the program.
Three phases in developing a *legally defensible* certification:

- Phase 1: Defining Need
- Phase 2: Development
- Phase 3: Evaluate, Monitor and Maintain
ASIC Sub-committee:

• Co-chairs:
  • Carey June, Doug Macdonald

• Committee Members:
  • Jim Barrett
  • Tom Shannon
  • Jim Laiche
Phase 1 – Defining Need

• Identify need for certification (Strategic Plan)
• Determine financial resources (Board of Directors) – collaboration with Irrigation Association was approved
Phase 2 - Development:

• **Step 1 - Job Analysis** First (most important) aspect and key to *legally defensible* certification
  
  • Objective; determine key aspects of job and related knowledge, skills & abilities to be measured by testing.
  
  • Focus group and/or survey to ensure broad review and participation by all stakeholders.
Job Analysis Goals

• Regardless of moving forward with certification or not, this process will provide benefits for the organization and members:
  • Help Create Awareness of ASIC and our profession
  • Establish key service areas that differentiate us from others (marketing)
Job Analysis Process

• Utilize 3rd Party with Job Analysis experience to direct process and ensure end results meet our organization’s goals
  • Psychometrician ensures that Job Analysis process provides measurable and definable content outline at the conclusion of the process
  • Psychometrics = Mental Measurement (testing of intelligence, not really psychology)
Job Analysis Process

- IA / ASIC Collaboration for Job Analysis
  - Leon Gross (Psychometrician) - PhD in statistics, 30 years experience, NCCA Commission for Accreditation
  - IA - Clover Belluz (Professional Development Director) & Deborah Hamlin (Executive Director) & multiple IA member representatives
  - ASIC “Blue Ribbon Panel” – Eight Professional Members

- Meeting conducted Jan 13-15, 2016 in Dallas to develop survey
Job Analysis Process

• On-line Survey submitted to IA and ASIC members in March 2016
• Survey results and demographics currently being compiled
• Meeting/presentation scheduled for July 11-13, 2016 in Orlando to review results
Phase 2 - Development:

- **Step 1: Job Analysis**
  BOD will determine whether to proceed beyond this point based on results

- **Step 2: Item Writing**
- **Step 3: Beta Testing and Item Performance Analysis**
- **Step 4: Exam Delivery and Maintenance**
QUESTIONS AND COMMENTS?